EOS MLS Instrument/Spacecraft Interface Concept

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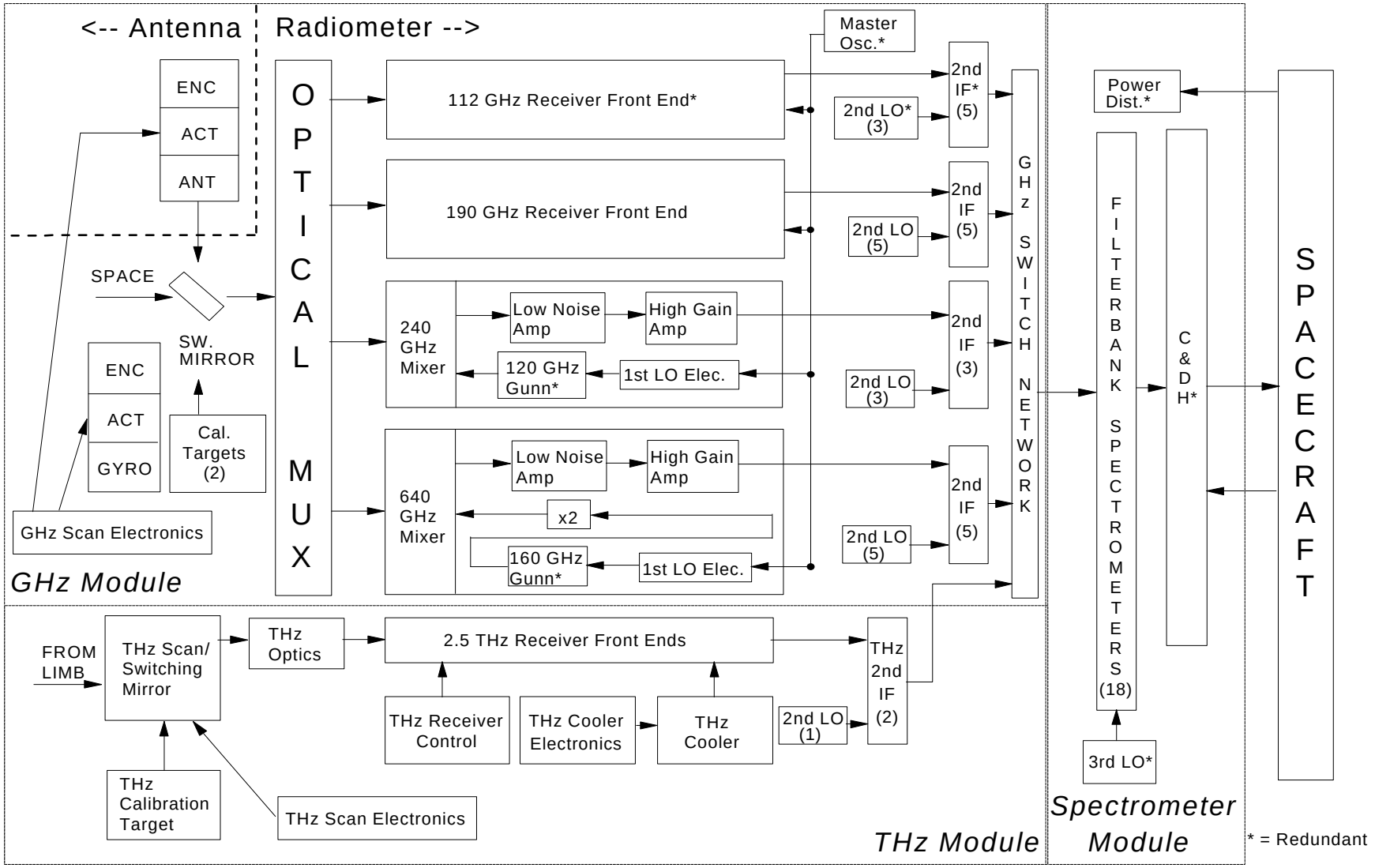
EOS MLS Instrument/Spacecraft Interface Concept
Instrument Description

- Three Modules: GHz, THz, and Spectrometer
- GHz Module:
  - Antenna design inherited from UARS MLS
  - Receivers ranging in frequency from 112 to 640 GHz with a common boresight
- THz Module:
  - 2 design options:
    - Hot electron bolometer mixer, photomixer 1st LO and mechanical cooler
    - Planar mixer with Gas Laser 1st LO
  - Contains its own scan mechanism and optics
- Spectrometer Module:
  - Houses Filterbank Spectrometer, C&DH and Power Distribution Assemblies

EOS MLS BLOCK DIAGRAM BOLOMETER 2.5 THz OPTION



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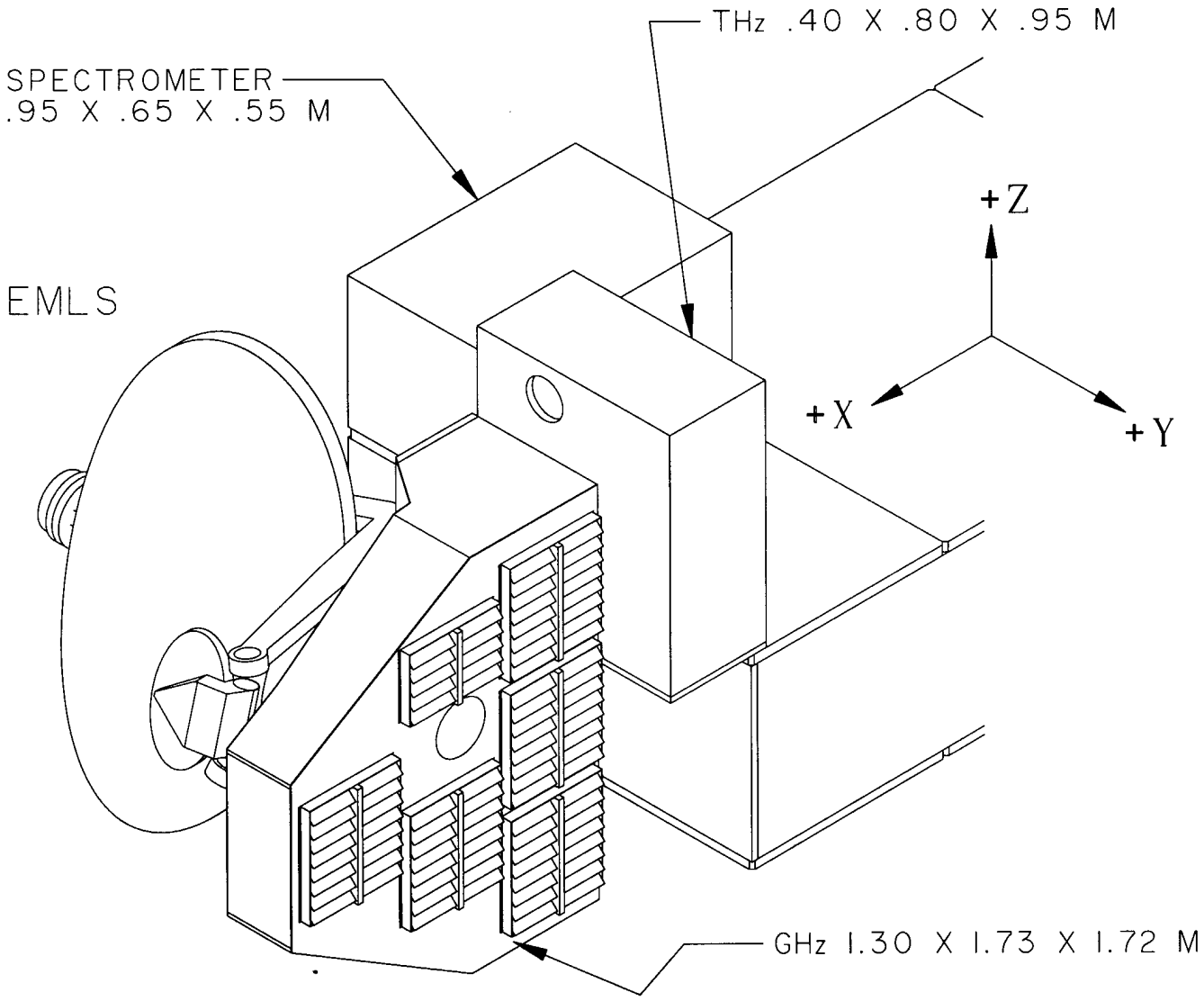

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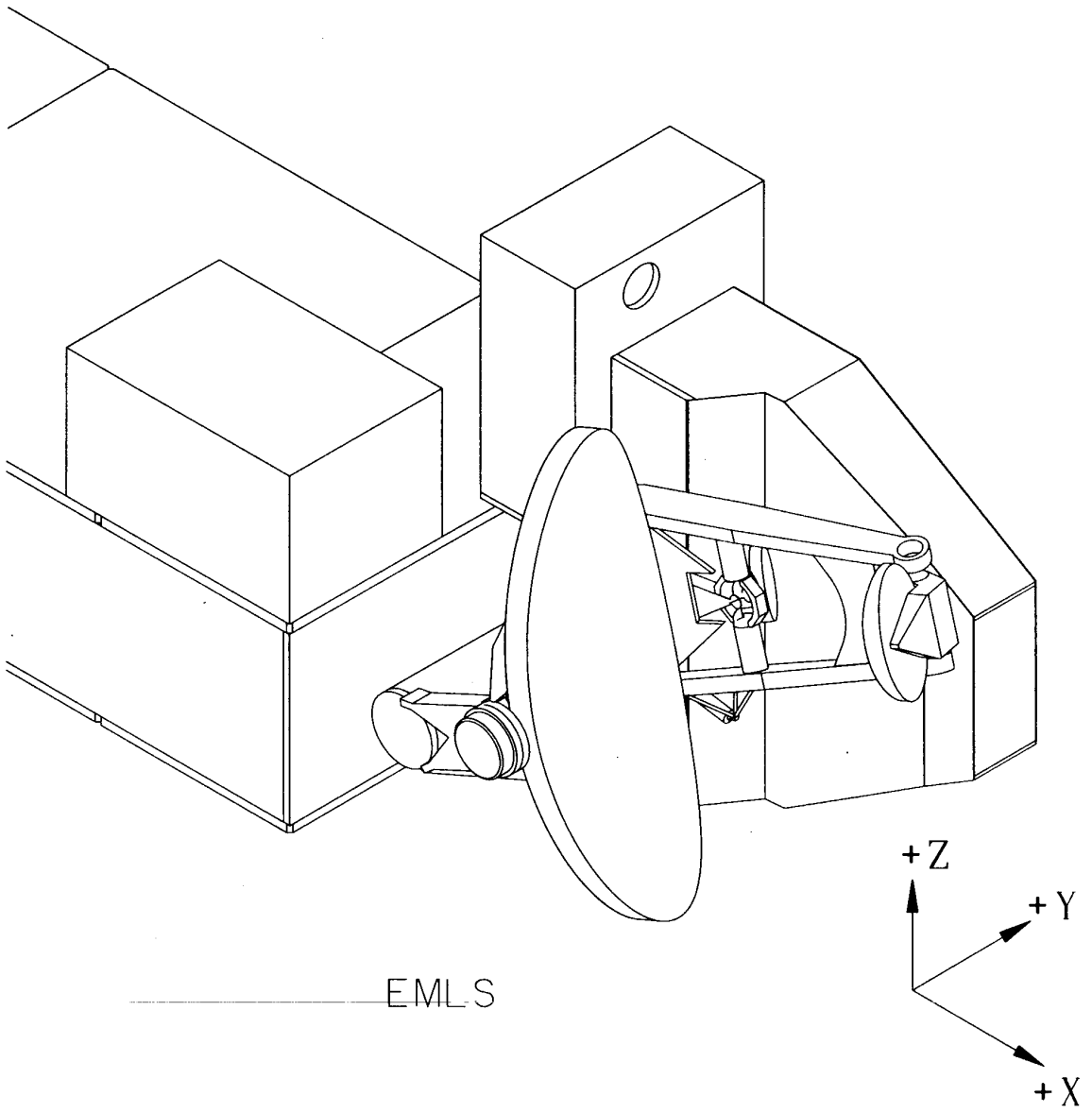

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Instrument Resources

Resource	Current Best Estimate Bolometer Option	Current Best Estimate Gas Laser Option
Mass (kg)		
GHz	225	225
THz	55	65
Spectrometer	95	105
Total	375	395
Power (W)		
GHz - quiet bus	179	179
noisy bus	16	16
THz - quiet bus	65	150
noisy bus	40	0
Spectrometer - quiet bus	95	105
noisy bus	0	0
Total	395	450
Envelope (m^3)		
GHz	1.30 x 1.73 x 1.72	1.30 x 1.73 x 1.72
THz	0.4 x 0.8 x 0.95	TBD
Spectrometer	0.90 x 0.65 x 0.55	0.95 x 0.65 x 0.55
Uncompressed Data Rate (kbps)	$\leq$ 100	$\leq$ 100

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Interfaces

- The MLS team is working to the General Interface Requirements Document (GIRD) for EOS Common Spacecraft/Instruments Revision A, January 1994, GSFC 422-11-12-01 including changes CH-01 & 02.
  - Currently comply with all GIRD requirements except:
    - Deviations proposed in the Draft version of the Unique Instrument Interface Document (UIID) for the Microwave Limb Sounder, September 1994, GSFC 424-28-24-02
    - Torque disturbances

Interface	Requirements
Mechanical	per GIRD; Kinematic mounts for GHz and THz modules; Hard mount for Spectrometer module
Thermal	per GIRD; Isolated; Cold space FOV required for the GHz module; Cold space and nadir FOVs required for the THz module; 0.6 m^2 cold space or 1.0 m^2 nadir FOV required for the Spectrometer
Electrical	per GIRD
Data	per GIRD

FOV (°)	
Along Track -- GHz and THz	55 to 77
Cross Track -- GHz and THz	$\pm$ 5

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Interfaces

- Unique MLS accommodation requirements:
  - Required at ground processing facility
    - High angular and temporal resolution “gyro” data
    - Temperature data and structural/thermal model for the spacecraft structure from the “gyro” to EOS MLS
    - Orientation and optical surface properties of any device/object close to the MLS FOV
    - Available quiet and pulse bus voltages and currents
    - Solar position in S/C coordinates
  - Required at the instrument
    - Oblateness data with a resolution of ~0.5 km or better
    - Periodic marker (once per orbit)

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Special Considerations

	Requirements
GHz Antenna Scan	Scan ~45 kg; ~1.2° pk-pk; 20 s one way, 4.7 s for retrace and calibration; repeated every 24.7 s
GHz Switching Mirror Scan (provides calibration)	Scan ~1 kg; 180° pk-pk; 1.7 s for movement, 3 s for view periods; repeated every 24.7 s
THz Antenna Scan	Scan ~1 kg; $\leq$ 2° pk-pk; 20 s one way; retrace accomplished by calibration target scan; repeated every 24.7 s
THz Calibration Target Scan	Scan ~1 kg; $\leq$ 155° pk-pk; 0.5 s one way, 1 s view period; repeated every 24.7 s
Pointing -- both Modules	
Control/Placement (arc sec)	180 pitch, 1800 roll/yaw
Jitter (arc sec/sec)	50 pitch, 1800 roll/yaw -- 0.1 to 30 s
Jitter Knowledge (arc sec/sec)	1 pitch, 10 roll/yaw (met by internal instrument gyro)
2.5 THz/GHz Co-Alignment	0.1° yaw and roll

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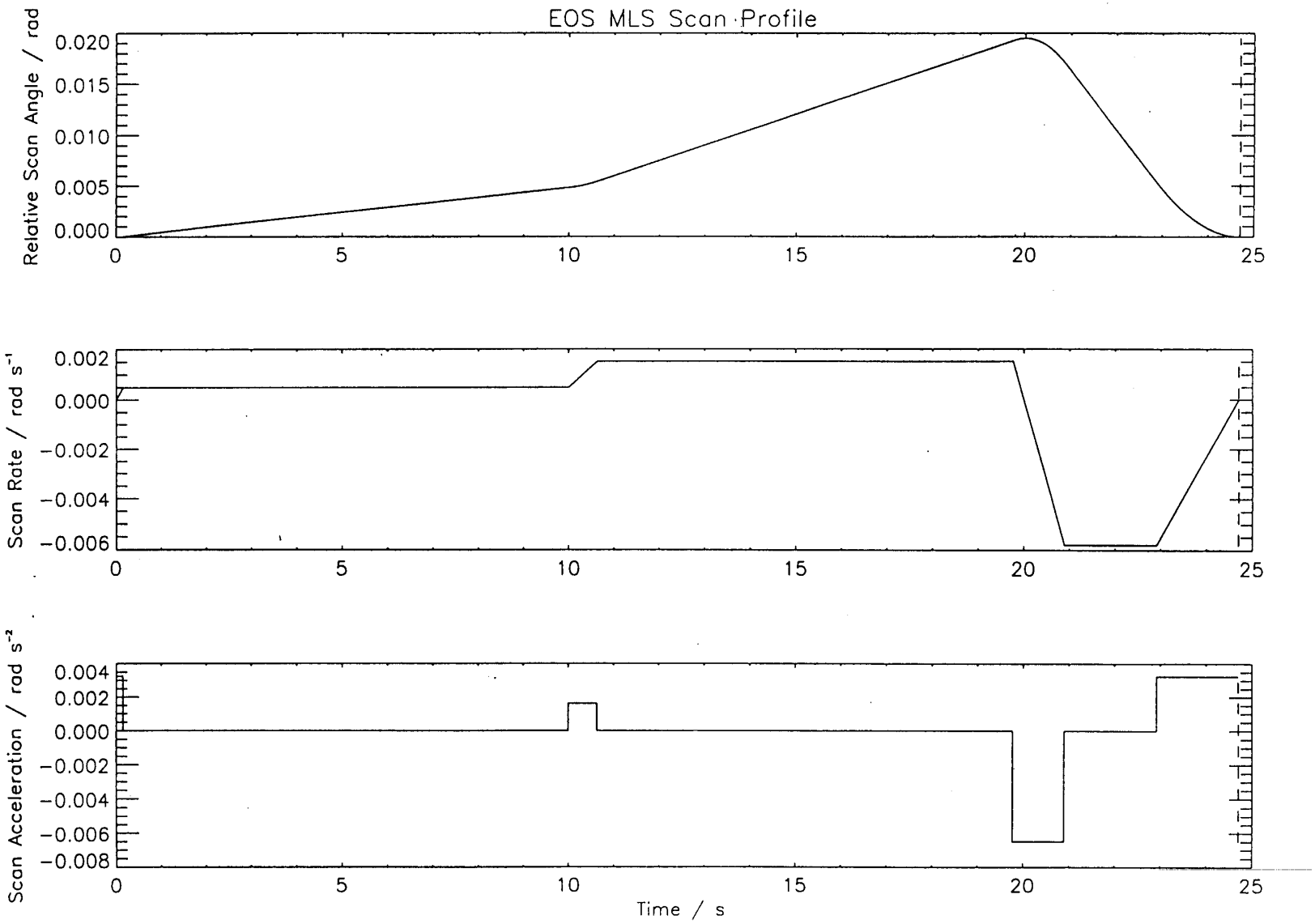
Special Considerations



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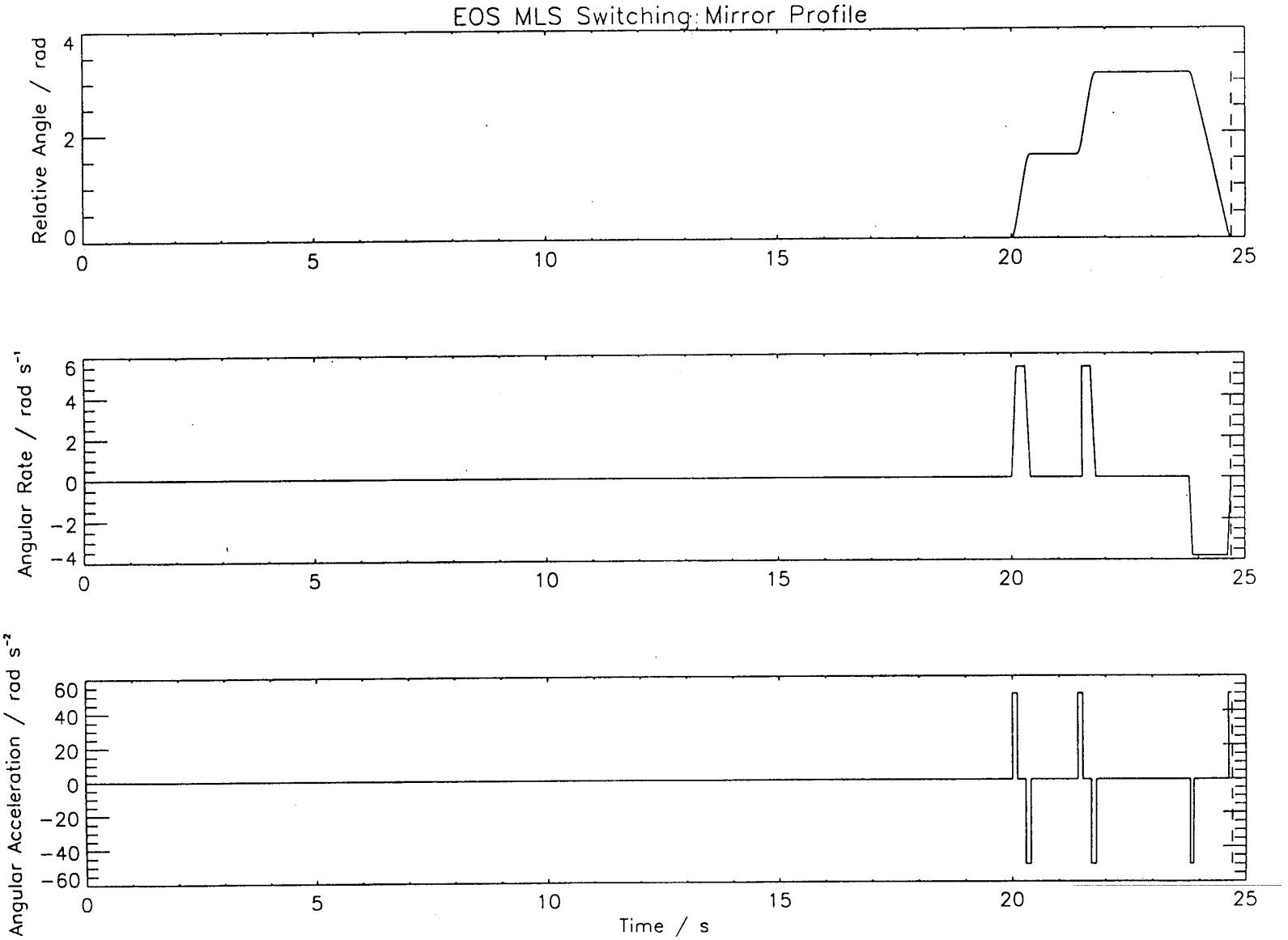

EOS MLS Instrument/Spacecraft Interface Concept
Flexibility

- The design of the overall EOS MLS Instrument/spacecraft system can be optimized.
  - The instrument gyro could be removed if the jitter knowledge requirements at the instrument can be met by the spacecraft. The sample rate for the gyro would need to be $\geq$ 12 Hz.
  - The Spectrometer module could be adapted to different dimensions or broken up if required. Some important considerations are:
    - the required cold space and nadir thermal FOVs listed previously,
    - filterbanks make up ~75% of the Spectrometer and require thermal stability of 0.01°C/min,
    - the maximum distance from the Spectrometer to the other modules is 3.0 m. The desired distance is $\leq$ 1.5 m.
  - The GHz and THz modules are currently being reconfigured. Changes in their envelope which would greatly benefit a spacecraft contractor should be discussed with us.

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Flexibility

- The instrument's Master Oscillator could be removed if the spacecraft provides a 5.000000 MHz signal with a stability of $\pm$ 1 x 10^{-7} or better over the life of the mission.
- The C&DH, power, thermal, and structural interfaces could also be optimized.
  - One example is that the instrument power interface could be simplified greatly if the bus is regulated to ~$\pm$ 2 V.
- Some of the estimated savings for the instrument are listed in the table below.

Item	Some Potential Savings if Provided by Spacecraft
Gyro	4 kg, 24 W, 21 x 17 x 13 cm^3
Master Oscillator	2 kg, 8 W, 20 x 20 x 5 cm^3
Power Interface	3 kg, 30 W, 20 x 20 x 5 cm^3

Potential GIRD Waivers Listed in the MLS UIID

- Optical Cube Surface:
  - Flatness - The surface shall be planar to within $\lambda/4$ rms, where λ is visible light.
  - Orthogonality - Knowledge of $\pm$ 1 arc sec

- Survival Heater Power:
  - The MLS survival power requirement is TBD% of the average instrument power.

- Connector Clearance:
  - Clearance provided around the outside of some of the mated connectors can be < 50 mm.

- Instrument Survival:
  - The MLS instrument shall withstand direct solar input into the primary reflector for 30 minutes without permanent degradation.

Potential GIRD Waivers Listed in the MLS UIID Continued

- Harness Provider:
  - Intra-instrument harness shall be provided by the Instrument Provider.

- Command Sequence
  - During ground testing and in-flight operation the application of power to MLS shall always be sequenced and executed in a prescribed order. i.e. All MLS electrical power loads shall not be powered by a single command. This waiver also applies when the spacecraft is recovering from an anomaly.

- Minimum Fixed Base Frequency:

  Each separately mounted instrument component, configured for launch, shall have a fixed base frequency of $\geq$ TBD Hz.